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INSTRUCTION MANUAL — PART ONE

MODEL LSA

ALL BAND, DIRECT READING

SPECTRUM ANALYZER

10 Mc — 16,520 Mc

DESCRIBING

SPECTRUM DISPLAY UNIT, MODEL LDU-1
KLYSTRON POWER UNIT, MODEL LKU-1
POWER UNIT, MODEL LPU-1

POLARAD ELECTRONICS CORP.

100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.
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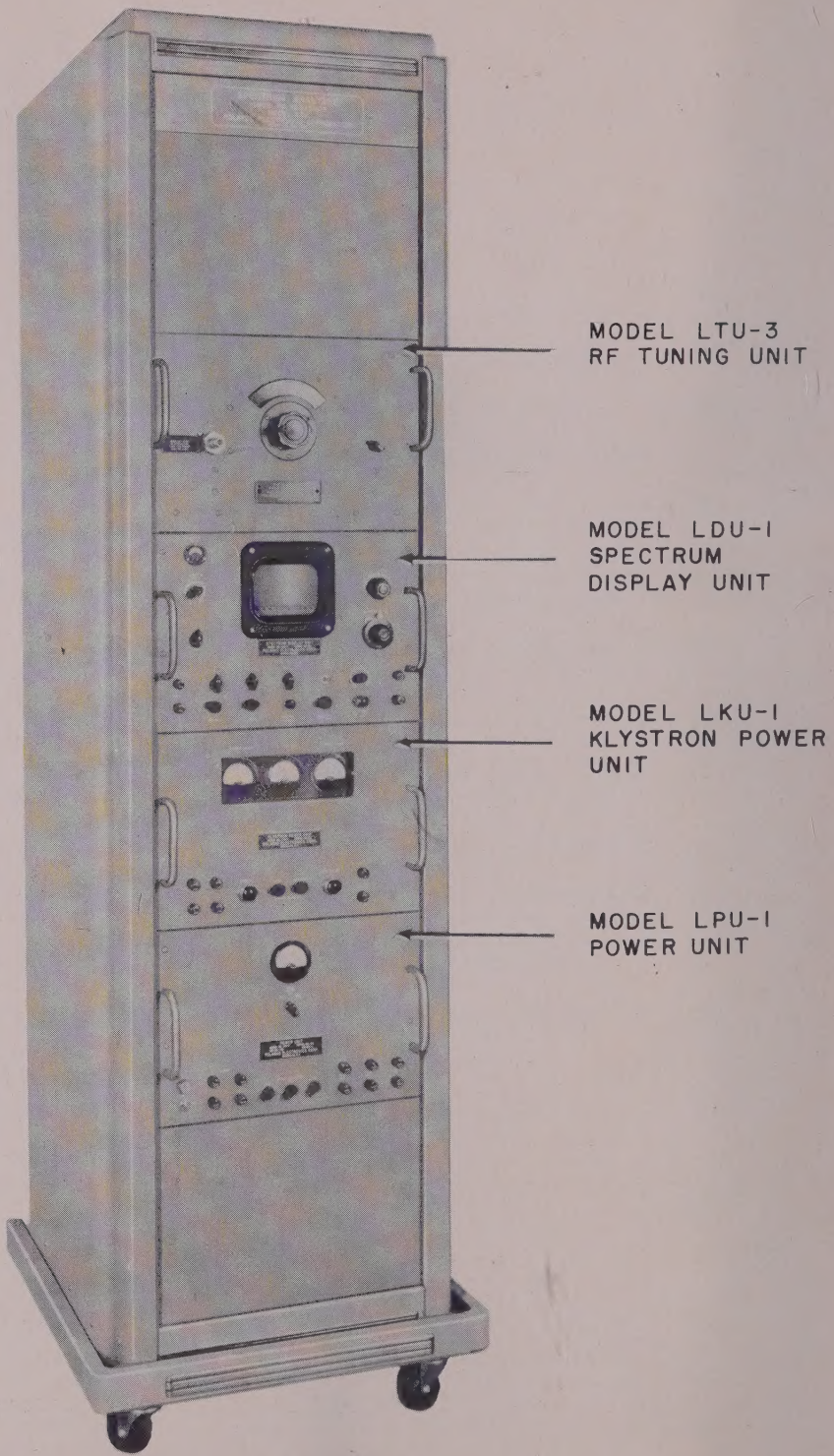

FIGURE 1. MODEL LSA SPECTRUM ANALYZER, FRONT VIEW.

PART I. THE POLARAD MODEL LSA SPECTRUM ANALYZER

SECTION I. GENERAL DESCRIPTION

1. INTRODUCTION.

a. The Model LSA All-band Direct-reading Spectrum Analyzer covers the frequency range from 10 Mc to 16,520 Mc. This manual describes the electrical and mechanical features of the three basic units of the equipment, including the Model LDU-1 Spectrum Display Unit, the Model LKU-1 Klystron Power Unit, and the Model LPU-1 Power Unit.

b. Part II of this Instruction Book describes Model LTU-1 RF Tuning Unit, covering the frequency range from 10 Mc to 1200 Mc; Part III describes Model LTU-2 RF Tuning Unit, covering the frequency range from 940 Mc to 4500 Mc, while Part IV is applicable to the Model LTU-3 RF Tuning Unit, with a frequency coverage from 4460 Mc to 16,520 Mc.

2. USES OF THE SPECTRUM ANALYZER.

a. Polarad's Model LSA Spectrum Analyzer is a laboratory instrument which is used to provide a visual indication of the frequency distribution of energy in an RF signal in the range covered by the Tuning Unit in use. The three RF Tuning Units receive CW and pulsed radio signals in the frequency range from 10 Mc to 16,520 Mc, and convert them to an intermediate frequency of 160 Mc, at a power level sufficient to drive the various circuits located within the Model LDU-1 Spectrum Display Unit. Signals detected are presented visually as a plot of voltage, on the vertical axis, versus frequency, on the horizontal axis, on a 5-inch cathode-ray tube screen in the Spectrum Display Unit. Controls are provided on the Display Unit front panel for observing on the screen a band of frequencies as narrow as 250 Kc, adjustable continuously to a band as wide as 28 Mc, as desired.

b. Specific uses of the equipment are:

(1) Observing and measuring sidebands associated with amplitude-and frequency-modulated signals;

(2) Determining the presence and accurately measuring the frequency of radio and/or radar signals;

(3) Checking the spectrum of magnetron oscillators;

(4) Measuring noise spectra;

(5) Checking and observing tracking of RF components of a radar system;

(6) Checking two RF signals differing by a small frequency separation.

3. MAJOR UNITS.

a. Figure 1 shows the three basic units of the Model LSA Spectrum Analyzer and one of the RF Tuning Units mounted within the deluxe steel cabinet rack supplied with the equipment. The major units are:

Polarad Model No.	Item	Description
LPU-1	Power Unit	Provides all the low voltage D.C. and A.C. power requirements of the system. D.C. voltages are electronically regulated and adjustable, with outputs monitored on the unit's front panel meter.
LKU-1	Klystron Power Unit	Provides the proper regulated voltages and the time delay for the application of these voltages to the klystron oscillators used in the Model LTU-2 and the Model LTU-3 RF Tuning Units. Anode and reflector voltages for the klystron tube are adjustable, with outputs monitored on front panel meters. (Not required for operation of the Model LTU-1 RF Tuning Unit.)
LDU-1	Spectrum Display Unit	Provides visual means for resolving and measuring accurately the spectrum of a radio frequency signal, within the range covered by the Tuning Unit in use. A variable frequency marker permits determination of frequency differences of as little as 250 kc, or as much as 28 mc.
LTU-1	RF Tuning Unit	Provides frequency coverage over the range from 9.5 mc to 1200 mc.
LTU-2	RF Tuning Unit	Provides frequency coverage over the range from 940 mc to 4500 mc.
LTU-3	RF Tuning Unit	Provides frequency coverage over the range from 4460 mc to 16,520 mc.

b. All interconnecting cables are supplied with the basic units of the Spectrum Analyzer. These cables are:

Part No.	Cable Description	Function
W1	Input power.	Connects Model LPU-1 Power Unit to 50/60 cps, 105-125 V, power source.
W2	Tuning Unit power.	Connects output of Model LPU-1 Power Unit to the Tuning Unit in use. In using the Model LTU-2 and the Model LTU-3 RF Tuning Unit, cable W2 supplies 115-volt 50/60 cps input to Klystron Power Unit, Model LKU-1.
W3	Display Unit power.	Connects output of Model LPU-1 Power Unit to Model LDU-1 Spectrum Display Unit.
W4	Klystron Power.	Connects Klystron Power Unit to the Model LTU-2 or the Model LTU-3 RF Tuning Unit. Input power to the Klystron Power Unit is supplied via cable W2; regulated output from the Klystron Power Unit is applied to the external-cavity klystron-oscillator within the Tuning Unit.
W5	Display Signal.	Connects the 160-Mc amplified output of the RF Tuning Unit to IF circuits within the Spectrum Display Unit, Model LDU-1.

c. A roller truck, which mounts the cabinet rack, is supplied with the basic units for providing ease in transportability of the equipment.

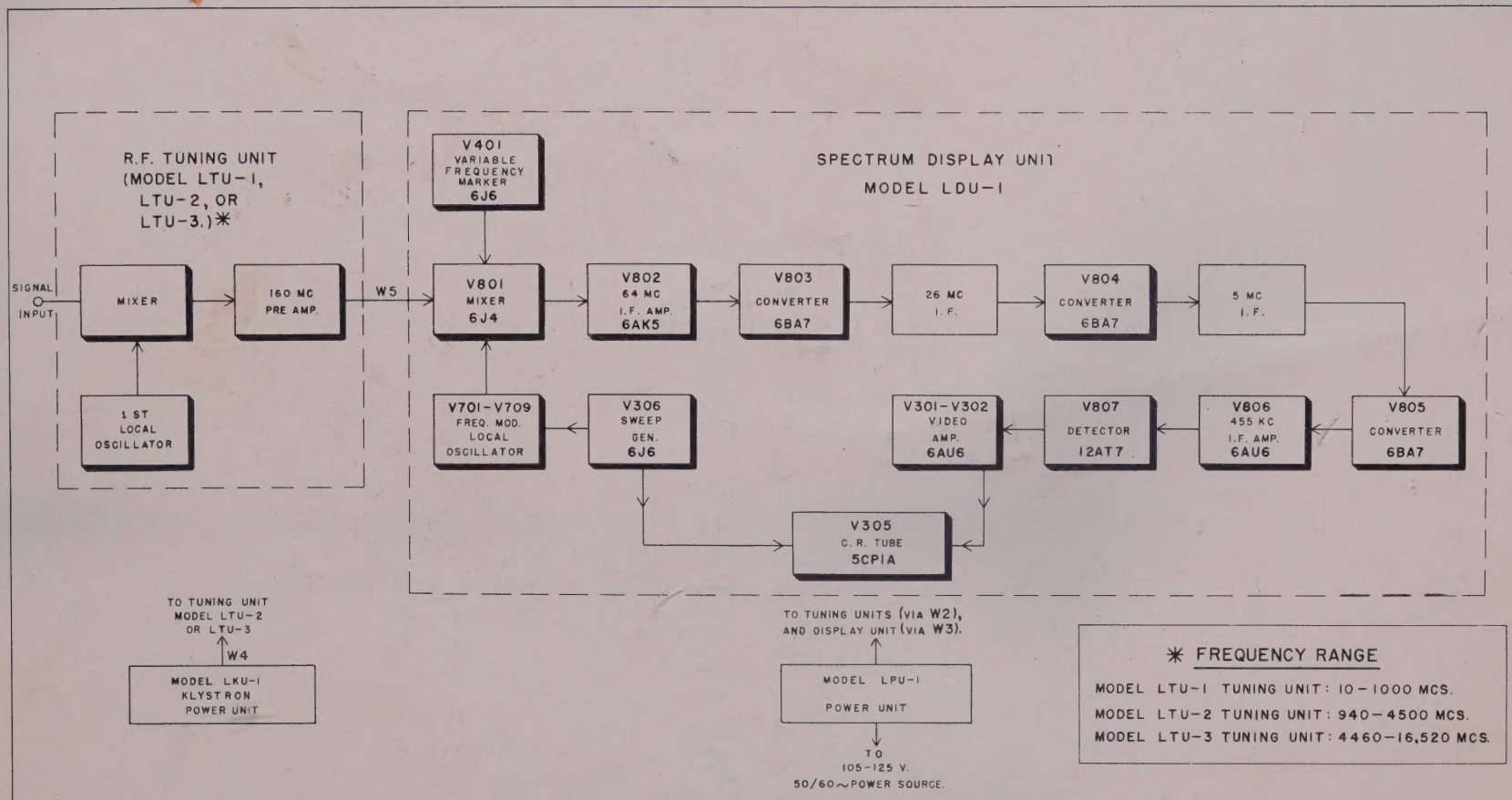

FIGURE 2.
MODEL LSA SPECTRUM ANALYZER,
FUNCTIONAL BLOCK DIAGRAM

SECTION II

SPECTRUM DISPLAY UNIT

MODEL LDU-1

1. DESCRIPTION
(Refer to figure 3.)

a. The Model LDU-1 Spectrum Display Unit is housed on a metal chassis having overall dimensions of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the equipment front panel.

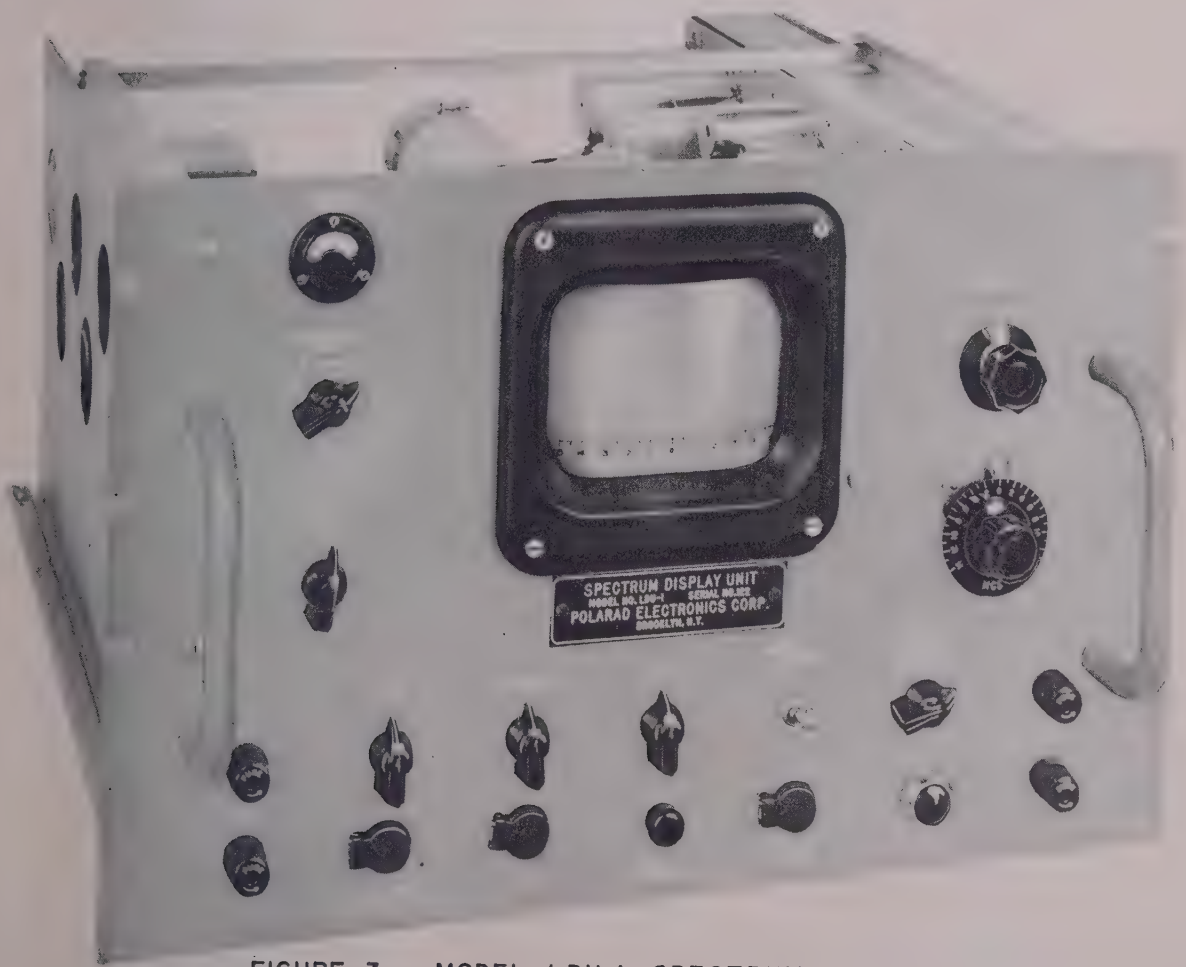

FIGURE 3. MODEL LDU-1 SPECTRUM DISPLAY UNIT, FRONT VIEW.

b. The unit consists of a narrow band amplifier, a variable-frequency marker oscillator, a sweeper circuit, and a 5-inch cathode-ray oscilloscope with its associated driving circuit. Figure 2 is a block diagram of the complete spectrum analyzer, showing the stages of the Spectrum Display Unit. (Refer to figure 8 for a schematic diagram of the Display Unit.) The Spectrum Display Unit receives a 160-mc signal from the RF Tuning Unit preamplifier. Sharp resolution of 5 kc, constant for all signal frequencies, is obtained by passing the resulting spectrum through the narrow band final IF amplifier. In addition to the usual scope controls, means for adjusting the sweep rate, center frequency, and frequency limits of the sweep oscillator are provided. An unusually distinct spectrum display is obtained by sweep blanking and beam intensification for the duration of the signal. The variable-frequency marker in the Display Unit can be used to determine frequency differences of as little as 250 kc or as much as 28 mc. It calibrates the spectrum display and helps determine frequency with great accuracy. A description of each of the components of the display unit is given below. Their location on the chassis is shown in figure 4.

(1). NARROW BAND AMPLIFIER -- The narrow band amplifier is mounted on the right side frame of the Spectrum Display Unit. The circuit consists of seven stages, designated tubes V801 through V807. The output of the 160 mc preamplifier and the output of the frequency-modulated second local-oscillator (operating at a center-frequency of 224 mc) are applied to the mixer tube V801. A resultant beat frequency of 64 mc is amplified in the second tube V802, and is coupled to the amplifier section of the third stage, which functions as a converter. The oscillator section of tube V803, tuned to 90 mc, mixes with the applied 64 mc signal to produce a 26 mc output. The fourth stage, V804, also functions as a converter, and has its oscillator section tuned to a frequency of 31 mc. As a result of heterodyning, the 5 mc output of the fourth stage is available for application to the final converter, tube V805. In this converter, the oscillator section is tuned to a frequency of 5.455 mc. The resultant 455 kc beat signal is amplified by an IF amplifier tube V806, and is coupled to one section of the 12AT7 twin-diode V807, which functions as a diode detector. This detected output is fed into a cathode follower, the second section of tube V807. The cathode follower output drives the vertical deflection amplifiers of the oscilloscope. The resolution of the spectrum analyzer is 5 kc, constant at all frequencies, and is determined by the 5 kc bandwidth of the final IF amplifier.

(2). MARKER OSCILLATOR -- The variable-frequency marker oscillator is mounted directly to the right of the cathode-ray tube, as viewed from the front of the equipment. This circuit employs a twin-triode 6J6 tube, designated V401, having a center frequency of 288 mc, with a tuning range 14 mc above and below its center frequency. With the FREQUENCY DIFFERENCE tuning knob set to its zero calibration mark, and with the BEAT FREQUENCY OSCILLATOR toggle switch set to its ON position, the oscillator produces an output of 288 mc, which appears as a positive pip on the spectrum display. This pip marks the center of the receiver pass-band, i.e., the frequency to which the tuning unit is set. Rotating the FREQUENCY DIFFERENCE dial causes this marker to move along the frequency scale on the cathode-ray tube screen in accordance with its tuning dial calibrations. Since the sweeper circuit is centered to produce an output of 224 mc, and the output of the marker oscillator is also applied to the first mixer stage V801 in the narrow band amplifier, a beat frequency of 64 mc is obtained at the output of the mixer tube. This 64 mc beat signal is amplified and converted to lower IF signals through the remainder of the receiver to appear as a vertical positive pip on the spectrum display screen. Setting the dial to a position other than its zero setting displaces the pip from the center of the pass-band within a range of ±14 mc.

(3). SWEEPER CIRCUIT -- The sweeper circuit is on a demountable chassis which is attached to the right side frame of the Spectrum Display Unit, directly beneath the narrow band amplifier. The circuit consists of nine stages, V701 through V709. Input voltage from the modulator driver stage V312 (in the oscilloscope circuit) is applied at proper DC level to the first tube V701, a reactance modulator, which drives the sweep-oscillator stage V702. The plate tank of this oscillator is tuned to a center frequency of 28 mc. The third stage, V703, amplifies this output signal. Tube V704 is a limiter. The 28 mc signal is then fed to the first frequency doubler

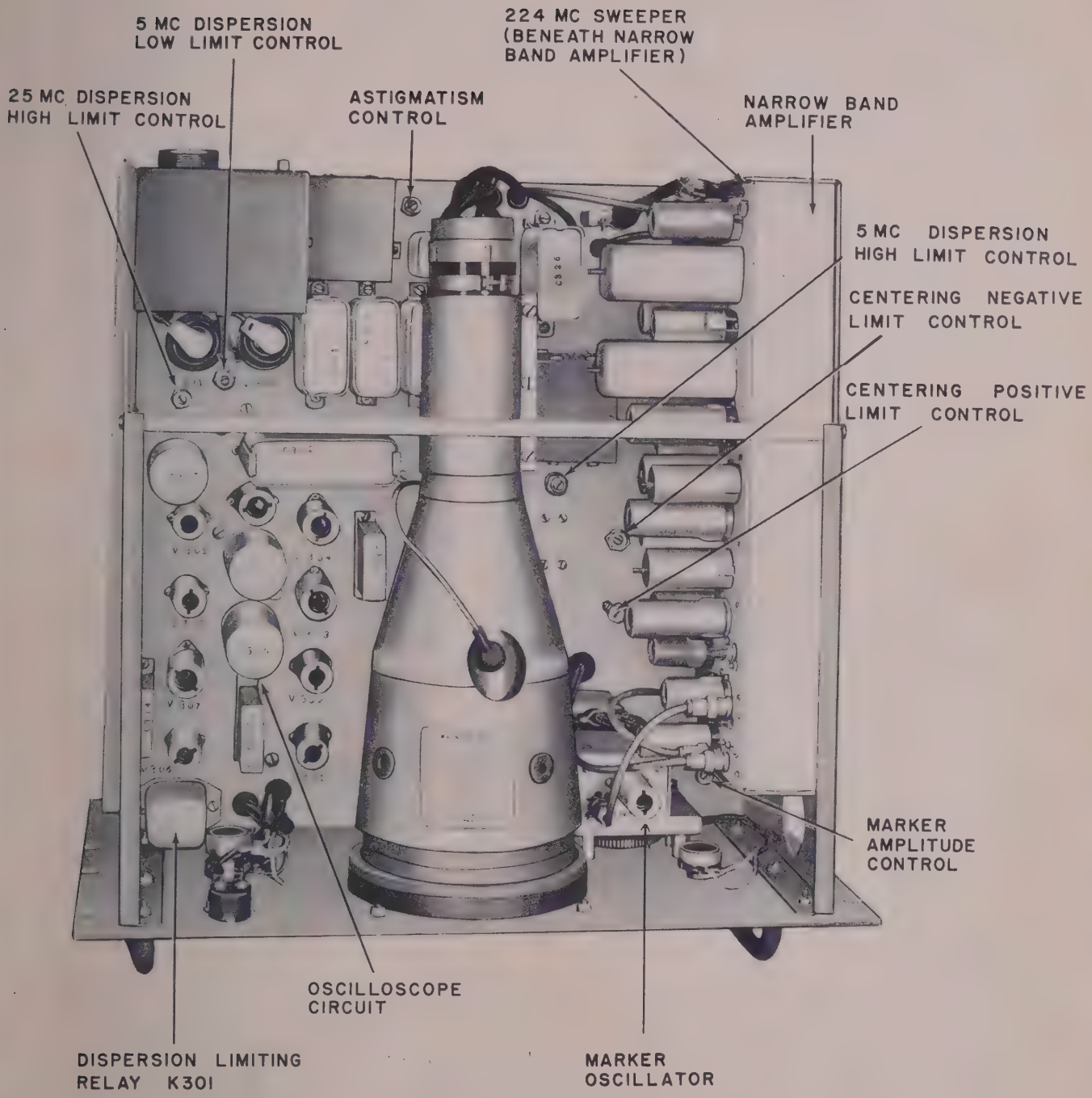

FIGURE 4. MODEL LDU-1 SPECTRUM DISPLAY UNIT, INTERIOR VIEW.

stage V705. The output of this stage is amplified by tube V706, and is then coupled to a second frequency doubler V707, producing an output signal of 112 mc. The third and final frequency doubler stage V708 has its plate tank circuit tuned to a frequency of 224 mc. The last stage, V709, is an output amplifier. The amplified signal is connected by coaxial cable to the input of the narrow band amplifier. Since the driving voltage applied to the reactance modulator stage V701 is a saw-tooth in time, the output of the reactance modulator stage varies linearly in frequency with time. Variation in output frequency (so-called "frequency dispersion"), set by means of the front panel FREQUENCY DISPERSION MEGACYCLES control, may be as narrow as 250 kc, or as wide as 28 mc, when the Model LTU-3, Model LTU-2, or the 100-1000 mc band of the Model LTU-1 RF Tuning Unit is used with the Spectrum Analyzer. When the 10-100 mc range of the Model LTU-1 Tuning Unit is used, a relay is automatically energized to limit the maximum pass band displayed to 5 mc.

(4). OSCILLOSCOPE CIRCUIT -- The oscilloscope circuit is mounted on the chassis of the Spectrum Display Unit to the left of the cathode-ray tube, as viewed from the front of the unit. The circuit consists of 12 stages, designated tubes V301 through V312. Input voltage from the cathode follower section of tube V807 (in the narrow band amplifier) is fed by coaxial cable to the phase inverter vertical amplifier tubes V301 and V302. Part of the output of tube V302 is fed to the intensifier section of the mixer stage V304. The amplified output of tube V304 is coupled to the control grid of the cathode-ray tube V305, and serves to intensify the beam for the duration of the signal. Tube V306 functions as the horizontal sweep generator. Its repetition rate may be varied between 5 to 20 cycles per second and may be synchronized to submultiples of the power line frequency. The sweep voltage is fed through one section of the twin-triode tube V307, acting as a phase inverter, which drives the push-pull sweep output stage, consisting of tubes V308 and V309. From the plate circuit of these tubes, the amplified sweep voltage is applied to the horizontal deflection plates of the cathode-ray tube. The second section of tube V307 amplifies the pulse, corresponding to the retrace of the sweep, and uses it to trigger the blanking-pulse generator tube V303. This stage functions as a one-shot multivibrator. The blanking pulse output of this tube is fed through one section of the mixer-amplifier stage V304. The output pulse of this stage is coupled to the control grid of the cathode-ray tube in such polarity that it blanks the cathode-ray tube beam for the duration of the sweep retrace. Tubes V310 and V311 are connected as a voltage-doubler rectifier circuit, providing high voltage for the operation of the electron gun and accelerator anodes of the cathode-ray tube. The final stage in the oscilloscope circuit, the twin-triode tube V312, takes the output of the sweep amplifier tube V307, and couples it, at proper dc level, to the reactance modulator in the 224 mc sweeper circuit.

2. OPERATING CONTROLS AND ADJUSTMENTS.

The operating controls and adjustments for the Spectrum Display Unit, Model LDU-1, are:

OPERATING CONTROLS AND ADJUSTMENTS

Control	Location	Function
VERTICAL CENTERING	Front panel.	Shifts the trace up or down on the cathode-ray tube screen.
HORIZONTAL CENTERING	Front panel.	Shifts the trace left or right on the cathode-ray tube screen.
SYNC	Front panel.	Synchronizes the sweep oscillator of the Spectrum Display Unit with the power line frequency.

OPERATING CONTROLS AND ADJUSTMENTS (continued)

Control	Location	Function
INTENSIFIER	Front panel.	Sets the amount by which the signal traces on the cathode-ray tube screen are intensified.
FOCUS	Front panel.	Focuses the trace on the scope screen.
BRIGHTNESS	Front panel.	Sets the general intensity level of the trace on the cathode-ray tube screen.
SWEEP SPEED	Front panel.	Permits adjustment of the repetition rate, within the limits of 5 to 20 cycles per second.
BEAT FREQUENCY OSCILLATOR ON-OFF	Front panel.	Applies operating power to the marker oscillator within the equipment.
FREQUENCY DISPERSION	Front panel.	Varies the frequency band displayed.
CENTER FREQUENCY	Front panel.	Controls the center frequency of the sweeper.
FREQUENCY DIFFERENCE	Front panel.	Permits re-locating the marker pip within plus and minus 14 megacycles of center.
VERTICAL GAIN	Front panel.	Varies the gain of the vertical-deflection amplifier and hence the height of the display appearing on the screen.
HORIZONTAL GAIN	Front panel.	Varies the gain of the horizontal-deflection amplifier and hence the length of the trace on the cathode-ray tube screen.
ASTIGMATISM	Rear center, top of chassis.	Used as a means of obtaining optimum focus of the electron beam over the entire face of the cathode-ray tube screen.
MARKER AMPLITUDE	Top of chassis, right front corner.	Varies the height of the positive marker pip on the screen, when the BEAT FREQUENCY OSCILLATOR switch is set to its ON position.
5 MC DISPERSION LOW LIMIT	Top of chassis, in front and to the right of tube V311.	Sets the minimum number of MC dispersion for the 5 MC dispersion range.
25 MC DISPERSON HIGH LIMIT	Top of chassis, directly in front of tube V311.	Sets the maximum number of MC dispersion for the 25 MC dispersion range.

Control	Location	Function
5 MC DISPERSION HIGH LIMIT	Top of chassis, in front of inductor L301.	Sets the maximum number of MC dispersion for the 5 MC dispersion range.
CENTERING POSITIVE LIMIT	Top of chassis, right side of CRT.	Sets the positive limit of the front-panel CENTER FREQUENCY control.
CENTERING NEGATIVE LIMIT	Top of chassis, right side of CRT.	Sets the negative limit of the front-panel CENTER FREQUENCY control.
NOISE LEVEL	Top of narrow band amplifier, left of V806.	Adjusts the desired residual noise level in the narrow band amplifier.

3. OPERATION.

a. To determine the frequency of an incoming RF signal:

(1) Connect the RF Tuning Unit that covers the band of frequencies to be scanned and detected, as indicated in figure 2.

(2) Observe that each INPUT jack on the Tuning Units is clearly marked for frequency coverage on the panel. Connect the incoming RF signal cable to the INPUT jack with panel markings showing that the signal falls within the appropriate frequency range.

(3) Rotate the main tuning dial until a pip, representing the incoming RF signal, appears on the screen. If the display is excessively large, vary either the external RF ATTENUATOR (if using the Models LTU-2 or LTU-3 RF Tuning Unit), the IF ATTENUATOR, and/or the VERTICAL GAIN control on the Spectrum Display Unit to control the height of the pip.

(4) Adjust the spectrum dispersion by varying the FREQUENCY DISPERSION control, on the Spectrum Display Unit front panel. This dial permits controls over the band of frequencies covered by the sweep-oscillator circuit. Frequency dispersion can be varied within the limits 250 kc to 28 mc, except on the 10-to-100 mc scale of the Model LTU-1 Tuning Unit. On that range, the maximum usable frequency dispersion is 5 mc. When the FREQUENCY DISPERSION control is set to its extreme counterclockwise position, and the HORIZONTAL GAIN control is at the extreme clockwise setting, the display on the screen will be expanded to a dispersion of approximately 50 kc/inch.

(5) Turn the BEAT FREQUENCY OSCILLATOR switch to its ON position. Turn the FREQ. DIFF. control to zero. This operation places the BFO marker pip at the electrical center of the display.

(6) If the marker pip is not visible or is not in the center of the display screen, vary the CENTER FREQUENCY control until the pip is properly centered on the display. The CENTER FREQUENCY dial permits investigation into any portion of the display appearing on the screen, over a band of frequencies that may be as narrow as 250 kc, and as wide as 28 mc, depending upon the setting of the FREQUENCY DISPERSION control, the HORIZONTAL GAIN control, and the Tuning Unit in operation (as explained in step 4, above).

(7) To determine the precise frequency of the incoming RF signal, slowly rotate the main tuning dial on the Tuning Unit in use until the signal pip merges with the marker pip. Read the frequency of the incoming RF signal directly from the dial.

(8) If information concerning the width of any lobe of a signal spectrum appearing on the display is desired, proceed as follows:

(a) Note that the FREQUENCY DIFFERENCE control is calibrated from minus 14 to plus 14 megacycles. Vary the FREQUENCY DIFFERENCE dial so that the marker pip is coincident with the low-frequency edge of the lobe whose width is to be measured. Record the setting of the dial.

(b) Rotate the FREQUENCY DIFFERENCE dial so that the marker pip travels across the display until the pip is coincident with the high-frequency edge of the lobe being measured. Record this setting of the dial.

(c) Calculate the difference in megacycles between the settings of the FREQUENCY DIFFERENCE dial in steps (a) and (b). This figure is the width in megacycles of a particular lobe appearing in the display.

(d) The procedure described immediately above is also applicable to measuring frequency differences between any two signals appearing in the display.

(9) The Spectrum Display Unit is designed to indicate increasing frequency from left to right except for the 4460 - 8500 mc range of the Model LTU-3 Tuning Unit. For that unit, and in that range only, increasing frequency reads from right to left on the display.

(10) It is important to distinguish between the true signal and the image. One factor aiding in this determination is the separation of 320 mc, which places the image relatively far away from the true signal on the frequency scale. However, they can be separated beyond doubt by noting that in all cases but one, when the tuning dial is rotated to higher frequencies, the true signal moves to the left, and the image moves to the right. (The exception is the 4460 - 8500 mc range of Model LTU-3 RF Tuning Unit. This is the only range in which the signal is 160 mc above the first local-oscillator and the true signal moves to the right.) On all the other frequency bands of the Spectrum Analyzer, the signal is 160 mc below the local-oscillator.

4. SPECIFICATIONS.

Indicator	Type 5CP1A green, medium persistence, 5 inch cathode-ray tube.
Spectrum display	Voltage on the vertical axis versus frequency on the horizontal axis.
Spectrum resolution	5 kc at all frequencies.
Frequency dispersion	Adjustable from 250 kc to 25 mc with RF Tuning Unit except on the 10-100 mc band of LTU-1, where it is adjustable from 250 kc to 5 mc.
Sweep repetition rate	5 to 20 cps, adjustable.
Input signal	160 mc
Intermediate Frequencies:	
Second IF	64 mc
Third IF	26 mc
Fourth IF	5 mc
Fifth IF	455 kc
Sweeper circuit	224 mc ± 12.5 mc
Frequency marker	288 mc ± 14 mc

Tube complement.....2-2X2A; 8-6AK5; 5-6AU6; 3-6BA7;
2-6J4; 3-6J6; 1-12AT7; 3-12AU7;
1-12AX7; 1-5CP1A.

Input: DC.....+ 105 v; + 150 v; + 300 v;
- 150 v.

AC.....115 v; 6.3 v.

5. MAINTENANCE.

a. MAINTENANCE DATA SUMMARY.

CAUTION

PERFORMANCE DATA OF THE SPECTRUM DISPLAY UNIT DEPENDS UPON THE SETTINGS OF THE CONTROLS. CONTROLS SHOULD BE ADJUSTED, AS INDICATED BELOW, BEFORE DATA IS TAKEN.

Control	Setting
FREQUENCY DISPERSION	25 mc.
SWEEP SPEED	15 cps.
VERTICAL GAIN	Maximum.
NOISE LEVEL	Full counterclockwise.
HORIZONTAL GAIN	Maximum.

(Controls not listed will have no effect on results.)

(1) A 60-cps signal, of 1-volt peak-to-peak magnitude, applied to the narrow band amplifier output cable results in a vertical deflection of approximately 2.1 inches. This is a measure of the performance of the video amplifier.

(2) A signal input of 64 mc, 30% modulated at a frequency of 400 cps, applied to the Display Unit SIGNAL input jack, yields a 1-volt increase over the residual level at the DIODE TEST pin jack of the narrow band amplifier, when measured with a vacuum-tube voltmeter. This is a measure of narrow band amplifier performance.

(3) A signal input of 160 Mc, of 100-microvolt amplitude, applied to the SIGNAL input jack at the rear of the chassis, yields a 1-inch vertical deflection on the cathode-ray tube screen. This is a measure of equipment overall performance, including the sweeper circuit.

(4) To check the alignment of the sweeper circuit and the IF amplifiers, connect a signal generator (capable of producing output over the frequency range from 148 mc to 172 mc) to the SIGNAL INPUT jack J802. As the signal generator is tuned over this range, the amplitude of the pip appearing on the screen remains within the limits of 3 db. Sweep linearity is verified by noting approximate equal horizontal pip displacement for a given frequency change, as the signal is varied.

(5) The data listed in steps (1) through (4) above is to be used in localizing

trouble within the equipment. The alignment procedures described below are to be performed only after the trouble has been localized and after a check of the tubes in the equipment have been eliminated as the source of trouble. See figure 8 for the schematic circuit diagram of the complete Spectrum Display Unit.

CAUTION

On those adjustable inductors provided with locknuts, be sure to unlock the nuts before attempting to make an adjustment. Also, be sure to tighten the locknut after each adjustment.

b. NARROW BAND ALIGNMENT PROCEDURE.

(1) Test equipment necessary for alignment consists of an external signal source, capable of producing output of 160 mc CW. If desired, the self-contained beat frequency oscillator within the Spectrum Display Unit may be utilized.

(2) Slide the Display Unit out of the cabinet rack, so that all of the alignment holes, on the right side of the narrow band amplifier chassis, are readily accessible.

(3) Connect the 160-mc signal source to the SIGNAL INPUT jack J802 on the Display Unit. Adjust the output of the signal source until the signal pip is displayed. Adjust the NOISE LEVEL control, located on the top side of the narrow band amplifier, until maximum sensitivity is obtained. Vary the tuning slug of transformer T804, also located on the top side of the narrow band amplifier, until the displayed signal reaches maximum amplitude. Repeat this procedure for the tuning slug of transformer T804 which is accessible through the access hole on the right side of the narrow band amplifier chassis. The remaining transformers and inductors are to be adjusted in the above manner, and in the following order:

1st.....T803, 2nd.....L814, 3rd.....T802, 4th.....L810, 5th.....T801,	6th.....L806, 7th.....L804, 8th.....L803, 9th.....L801.

For best results, repeat the entire alignment procedure at least once. When alignment is completed, re-adjust the NOISE LEVEL control, rotating its shaft in a counterclockwise direction, in order to decrease the sensitivity until residual noise level is barely visible on the cathode-ray tube screen.

c. 224 MC SWEEPER CIRCUIT ALIGNMENT.

(1) If alignment of the 224 mc sweeper circuit is required, remove the sweeper strip from the right side frame of the Spectrum Display Unit, directly beneath the narrow band amplifier. Then remove the dust cover surrounding the sides and bottom of the strip, so that the terminals on the tube sockets on the under side of the chassis are accessible.

(2) Set the FREQUENCY DISPERSION control fully clockwise, and rotate the HORIZONTAL GAIN control so that the sweep trace covers the entire width of the display screen.

(3) Remove the sawtooth input signal to the sweeper circuit by removing tube V306 from its socket. Keep cathode-ray tube intensity low.

(4) Use a wavemeter capable of tuning within the range of 28 mc, a high-impedance vacuum-tube voltmeter, a 1-megohm resistor, and an RF voltmeter capable of indicating potentials up to 1 volt.

(5) Insert the probe of the DC vacuum-tube voltmeter into the BIAS TEST pin jack, located near V-701. For proper sweep linearity, a bias voltage of about 1.7 to 3.0 volts is required. Rotate the CENTER FREQUENCY control on the front panel of the Display Unit until the proper indication is observed on the voltmeter.

(6) Place the wavemeter, tuned to 28 mc, in the vicinity of L701 at the output of V702. Tune the adjustment screws until the wavemeter indicates resonance. If 28 mc response cannot be obtained within the above bias range, adjust T701 or L718 to different values and repeat above. The inductance (L718) in the cathode circuit of V701 controls low-frequency sweep linearity, while the bi-filar winding controls sweep sensitivity. If the oscillator fails to produce output, tubes V701 and V702 may have to be changed.

(a) After the oscillator has been properly tuned to 28 mc, connect the vacuum-tube voltmeter, through the 1-megohm resistor, to the grid of V704. Tune L702 adjustment until a maximum reading is obtained on the VTVM.

(b) Also tune L703 adjustment for maximum output.

(c) Connect the VTVM to the grid of V705 through the 1-megohm resistor, and tune L704 for maximum output.

(d) Repeat the procedure of step (a), above, for the remaining tubes V705 through V709, and inductors L705 through L711.

(e) The tuning slugs of inductors L712 and L713 are to be adjusted to give maximum amplitude of the BFO marker signal on the Display Unit screen.

(7) If the sweep is non-linear, or if the range is not covered, either reset inductor L702 for a better center frequency (28 mc), reset the bias voltage (as described in step 5, above), or vary the slugs of transformer T701 and/or of inductor L718. In general, increasing the inductance of L718 and T701 increases sweep range and sensitivity ("frequency deviation") per bias change, at the expense of weakening the output from the sweep oscillator. Be sure to reset inductor L702 after re-adjusting inductor L718 and/or transformer T701. Repeat the procedure in this step until the desired results are obtained. If necessary, change tube V701 and/or V702 to obtain satisfactory sweep linearity.

SECTION III

POWER UNIT, MODEL LPU-1

1. DESCRIPTION.
(Refer to figure 5.)

a. The Model LPU-1 Power Unit is housed on a metal chassis having overall dimensions of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the front panel. The unit consists of four electronically-regulated power supplies, delivering the following output voltages and current: positive 105-volt @ 200 ma; positive 150-volt @ 200 ma; positive 300-volt @ 60 ma; and negative 150-volt @ 20 ma. (See figure 9 for schematic circuit diagram.) In addition, the nominal 115-volt 50/60 cps power line voltage is fed to appropriate terminals on the TUNING HEAD receptacle and the DISPLAY UNIT receptacle at the rear of the chassis. The three positive dc outputs of the Model LPU-1 Power Unit are monitored by means of a front panel meter, calibrated from 0 to 200 volts on one scale, and from 0 to 400 on a second scale. A METER SELECTOR, located directly beneath the meter, switches these voltages into the meter circuit. Screwdriver controls, at the bottom center of the front panel, are provided for adjustment of the positive voltages.

FIGURE 5. MODEL LPU-1 POWER UNIT, FRONT VIEW.

b. The Model LPU-1 Power Unit is used as the power source for the Spectrum Display Unit, for the preamplifier circuits in the RF Tuning Unit, and for the first local-oscillators in the Model LTU-1 RF Tuning Unit. In addition, the Model LPU-1 Power Unit supplies the nominal 115-volt input to the Model LKU-1 Klystron Power Unit. Protection against overloads and short circuits is provided by the 10-ampere fuses, in each leg of the power line. Additional protection against short-circuiting all positive dc power supplies is provided by a $\frac{1}{2}$-ampere fuse in the plate circuit of each series control tube. All operating fuses and spare fuses are accessible from the front panel.

2. OPERATING CONTROLS & ADJUSTMENTS.

The operating controls and adjustments for the Power Unit, Model LPU-1, are tabulated below. All controls and fuses are mounted on the front panel.

Control	Function
POWER SWITCH.	Connects the 105-125 volts, 50-60 cps, supply voltage at POWER INPUT jack J1 to the power supply.
METER SELECTOR.	Monitors the positive dc regulated output of the Power Unit at the 300 v, 150 v, and 105 v positions.
VOLTAGE ADJUSTMENT.	A separate screwdriver-control sets the output voltage of each positive regulated supply for the 300-volt output, the 150-volt output, and the 105-volt output.

3. SPECIFICATIONS.

Output.....+ 105 v @ 200 ma;
+ 150 v @ 200 ma;
+ 300 v @ 60 ma;
- 150 v @ 20 ma.

Impedance.....1.5 ohm.

Regulation.....0.2%

Ripple.....10 mv, rms.

Tube Complement.....4-5R4GY; 2-6AS7G; 2-6AU6;
1-6SL7; 4-0A2, 1-6L6G.

Input.....105-125 v, 50/60 cps, 300 watts.

SECTION IV

KLYSTRON POWER UNIT, MODEL LKU-1

1. DESCRIPTION.
(Refer to figure 6.)

a. The Klystron Power Unit, Model LKU-1, is housed on a metal chassis having overall dimensions of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the equipment front panel. The unit consists of two high-voltage electronically regulated power supplies. (See figure 10 for schematic circuit diagram.) The supply used for the reflector electrode of the klystron tube is at a potential of 600 volts, floating with respect to ground. It is permanently connected to the negative side of the klystron anode supply. One of three voltages is available from the anode supply, consisting of 300-volt output, 400-volt output, or 1000-volt output. The proper anode supply is selected automatically by the tuning units through the use of relays. The relays perform two functions: they change the transformer tap to give the necessary voltage at the regulator tube, and they change the reference voltage. When the Klystron Power Unit is energized, the reflector supply is immediately energized. A time delay relay delays the application of power to the anode supply for approximately 60 seconds. Three meters on the front panel monitor the anode supply voltage, the reflector supply voltage, and the cathode current of the klystron oscillator tube.

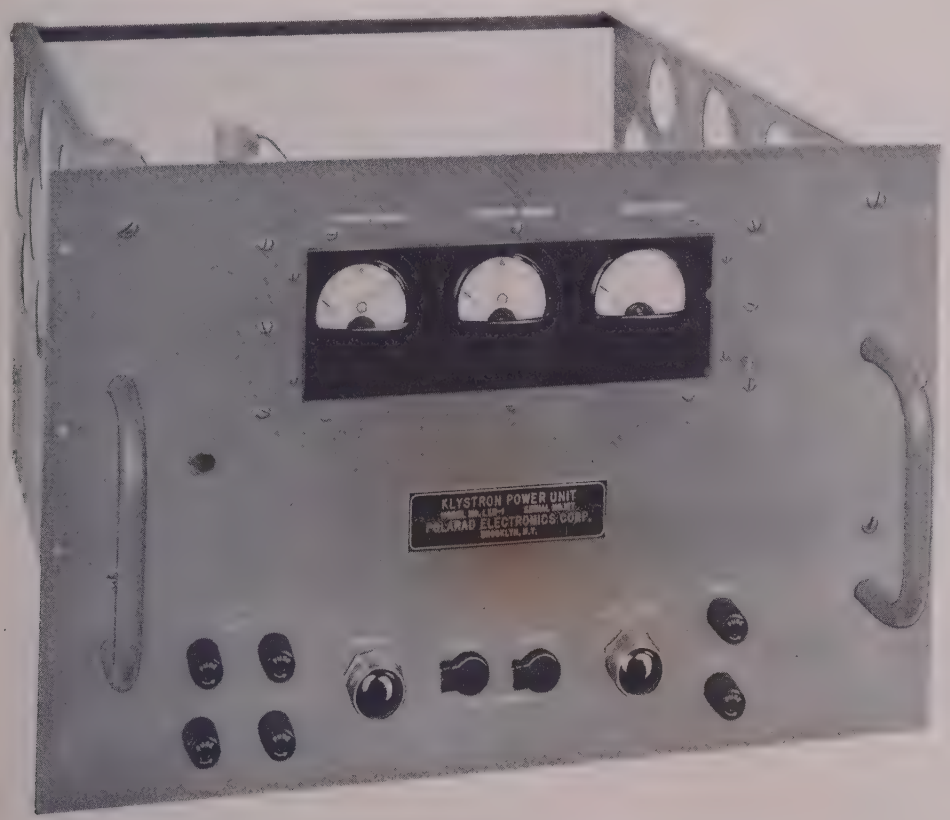

FIGURE 6. MODEL LKU-1 KLYSTRON POWER UNIT, FRONT VIEW.

b. The Klystron Power Unit is used as the power source for the reflex klystron, which is the first local-oscillator in the Model LTU-2 and in the Model LTU-3 Tuning Units. The ac input to the unit is obtained from the Model LTU-2 or the Model LTU-3 Tuning Unit via the Tuning Unit power cable W2, from the Model LPU-1 Power Unit. The required input to the Klystron Power Unit is 105/125 volts, 50/60 cps, 300 watts, and 150 volt dc (for relay operation). The regulated and adjustable dc output voltages from the Klystron Power Unit are applied to the appropriate electrodes of the klystron tube within the RF Tuning Unit by means of the Klystron Unit power cable, W4. Protection against overloads and short circuits is provided by the 5-ampere fuses in both legs of the input to the power transformers. Additional protection against overloads in the klystron anode circuit is provided by a 1/8 ampere fuse in the plate circuit of the high-voltage series-regulator tube, V103. All operating fuses, and spares for each, are accessible from the front panel.

NOTE

THE KLYSTRON POWER UNIT IS NOT USED FOR OPERATING THE MODEL LTU-1 RF TUNING UNIT, WHICH COVERS THE 10-1000 MC FREQUENCY RANGE.

2. OPERATING CONTROLS AND ADJUSTMENTS.

The operating controls and adjustments for the Klystron Power Unit, Model LKU-1, are tabulated below. All controls are located on the front panel.

Control	Function
REFLECTOR VOLTAGE ADJUSTMENT.	Sets the output voltage of the 600-volt regulated reflector voltage supply. (Screwdriver control.)
ANODE VOLTAGE ADJUSTMENT.	Sets the output voltage of the power supply circuit for the anode of the reflex klystron tube. (Output is 400 volts or 1000 volts, depending on the Tuning Unit employed.) (Screwdriver control.)

3. SPECIFICATIONS.

Output.....-300 v @ 50 ma or -400 v @ 50 ma or -1000 v @ 25 ma; 600 v @ 10 ma.

Ripple.....Less than 0.003%.

Input.....105/125 v, 50/60 cps, 300 watts.

Tube Complement.....1-5R4GY; 2-6SL7GT; 2-6Y6G; 2-1616; 7-0A2; 1-0B2.

SECTION V

STARTING PROCEDURE

1. INTER-UNIT CABLING CONNECTIONS.

a. Connect the units by means of the inter-unit cables as described below. (See Inter-Unit Cabling Diagram, figure 9.)

(1) Connect Input Power cable W1 from the Model LPU-1 Power Unit POWER IN receptacle J1, located on the chassis rear panel, to a 105-125 volt, 50/60 cps power source, capable of delivering 600 watts of power.

(2) Connect Tuning Unit power cable W2 from the Model LPU-1 Power Unit TUNING HEAD receptacle J2, located on the chassis rear panel, to the POWER receptacle located on the rear of the desired RF Tuning Unit.

(3) Connect Display Unit power cable W3 from the Model LPU-1 Power Unit DISPLAY receptacle J3, located on the chassis rear panel, to the POWER receptacle J301, the large multi-pin connector at the rear of the Spectrum Display Unit chassis.

(4) Connect coaxial cable W5 from the UG-291/U receptacle on the rear of the RF Tuning Unit chassis, to the UG-291/U SIGNAL jack J302, located at the rear of the Spectrum Display Unit chassis.

(5) When operating either the Model LTU-2 or Model LTU-3 RF Tuning Unit, be sure to connect Tuning Unit Klystron power cable W4 from the Model LKU-1 Klystron Power Unit receptacle J101, to the KLYSTRON POWER receptacle at the rear of the RF Tuning Unit chassis. This cable supplies high-voltage DC to the klystron-oscillator tube elements, and high-current 6.3 volt ac power to the klystron tube heater. Tuning Unit Klystron Power cable W4 is not used when operating with the Model LTU-1 RF Tuning Unit.

2. STARTING PROCEDURE.

WARNING

IF THE REFLECTOR SUPPLY VOLTAGE IS NOT PRESENT WITHIN 30 SECONDS AFTER POWER IS APPLIED, TURN THE MAIN POWER SWITCH ON THE MODEL LPU-1 POWER UNIT OFF!

a. After the POWER switch on the front panel of the Model LPU-1 Power Unit is turned ON, and while the Spectrum Analyzer is allowed to warm up for at least 10 minutes, the following indications should occur:

(1) The red pilot lamps on the front panels of all the basic units light up. The dial on the Tuning Unit in use becomes illuminated.

(2) After about 30 seconds, the voltmeter located on the front panel of the Model LPU-1 Power Unit indicates a reading. The value indicated depends on the setting of the METER SELECTOR.

(3) About 30 seconds after applying power, the REFLECTOR VOLTAGE meter at the top center of the Model LKU-1 Klystron Power Unit front panel indicates a 600-volt reading. If this meter fails to indicate a reading after the 30-second period, be sure to turn the main power switch on the Model LKU-1 Power Unit OFF, and search for the cause of trouble.

(4) About 60 seconds after throwing the POWER switch ON, a trace appears on the cathode-ray tube screen of the Model LDU-1 Spectrum Display Unit.

(5) After a delay of approximately 60 seconds, the following indications are observed:

(a) The ANODE VOLTAGE ON pilot and the ANODE VOLTAGE meter on the front panel of the Model LKU-1 Klystron Power Unit are energized when the Model LTU-2 or the Model LTU-3 RF Tuning Unit is in use. Proper meter readings are 400 volts, with the Model LTU-2 Tuning Unit, and 1000 volts, with the Model LTU-3 Tuning Unit.

(b) The CATHODE CURRENT meter on the Klystron Power Unit front panel indicates a reading of 40 ma with the Model LTU-2 Tuning Unit in use, or 22 ma with the Model LTU-3 Tuning Unit in use, after the Tuning Unit has completed its warm-up period. During warm-up, the meter will read off-scale when the Model LTU-2 Tuning Unit is in use, and will read high values when the Model LTU-3 Tuning Unit is in use.

(c) The CRYSTAL CURRENT meter, located in the upper left corner of the Spectrum Display Unit front panel, indicates a reading, except when the 10-to-100 mc band of the Model LTU-1 RF Tuning Unit is in use.

3. INITIAL ADJUSTMENTS.

a. Since proper operation of the Model LSA Spectrum Analyzer is dependent on correct initial adjustments, check adjustments in the order indicated below:

(1) FOR THE MODEL LPU-1 POWER UNIT: Rotate the METER SELECTOR to each of its positions. If the panel voltmeter fails to indicate the proper voltage at the 105 V., 150 V., and/or the 300 V. positions of the METER SELECTOR, lift the jack cover for the appropriate VOLTAGE ADJUSTMENT, insert a screwdriver and rotate the adjustment screw counter-clockwise; then approach the desired voltage-setting in a clockwise direction.

(2) FOR THE MODEL LKU-1 KLYSTRON POWER UNIT:

a. If the voltmeter fails to read 600 volts when the Klystron Power Unit is on, lift the jack cover over the REFLECTOR VOLTAGE ADJUSTMENT panel marking, and insert a screwdriver. First rotate the adjustment screw in a counter-clockwise direction. Then approach the desired 600-volt setting by rotating the potentiometer arm in a clockwise direction.

b. ANODE VOLTAGE of the reflex klystron oscillator is indicated on the right-hand panel meter. If the voltmeter fails to indicate the proper voltage, lift the jack cover over the ANODE VOLTAGE ADJUSTMENT, then rotate the adjustment screw in a counter-clockwise direction first, and approach the proper voltage setting in a clockwise direction.

(3) FOR THE MODEL LDU-1 SPECTRUM DISPLAY UNIT: A sweep trace appears on the cathode-ray tube screen of the Spectrum Display Unit within approximately 60 seconds after turning the POWER switch on the Model LPU-1 Power Unit ON. If no trace appears within a reasonable time, adjust the BRIGHTNESS, FOCUS, HORIZONTAL GAIN, and VERTICAL GAIN controls until a desirable trace appears.

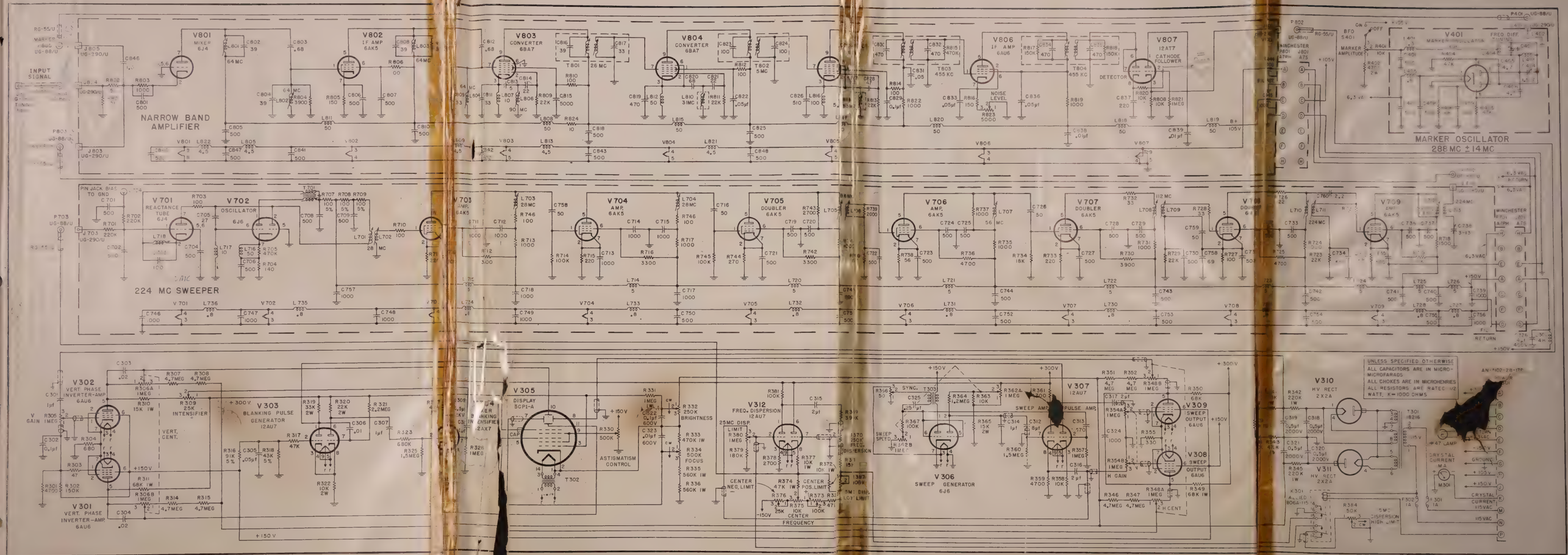

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FIGURE 7. DISPLAY UNIT (PART OF SPECTRUM ANALYZER) MODEL LDU-1

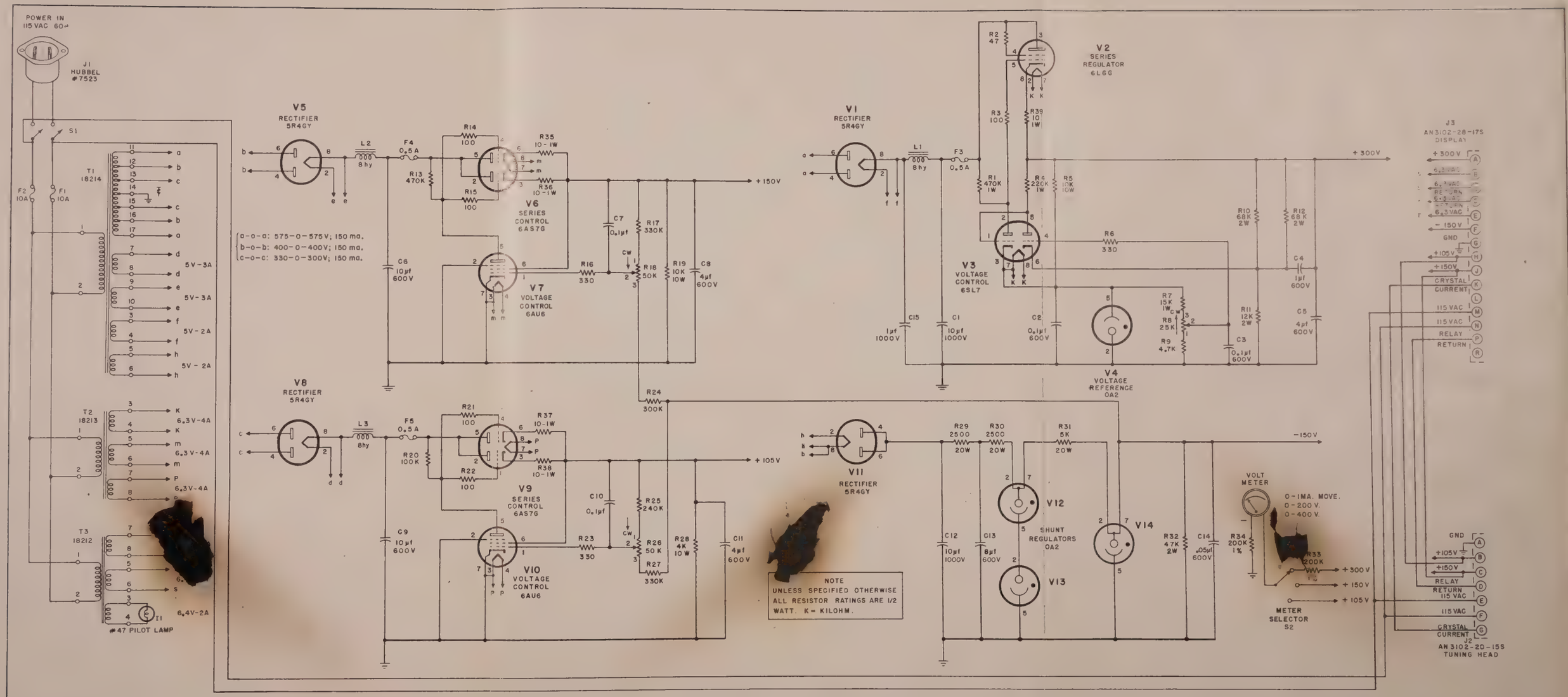
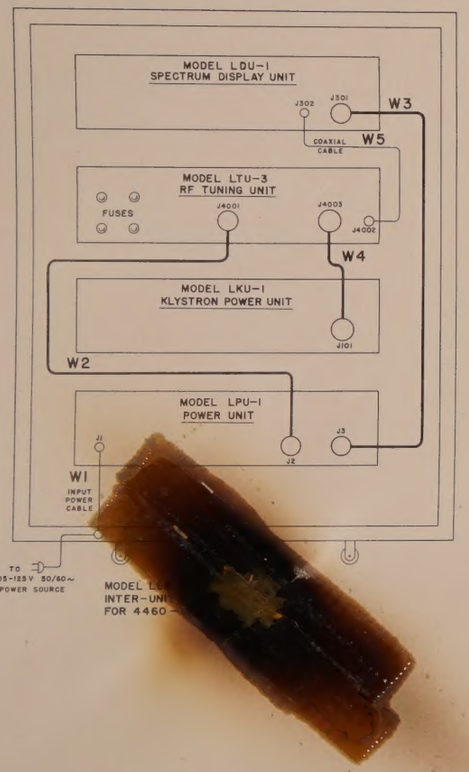


FIGURE 8. MODEL LPU-1 POWER UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC DIAGRAM.



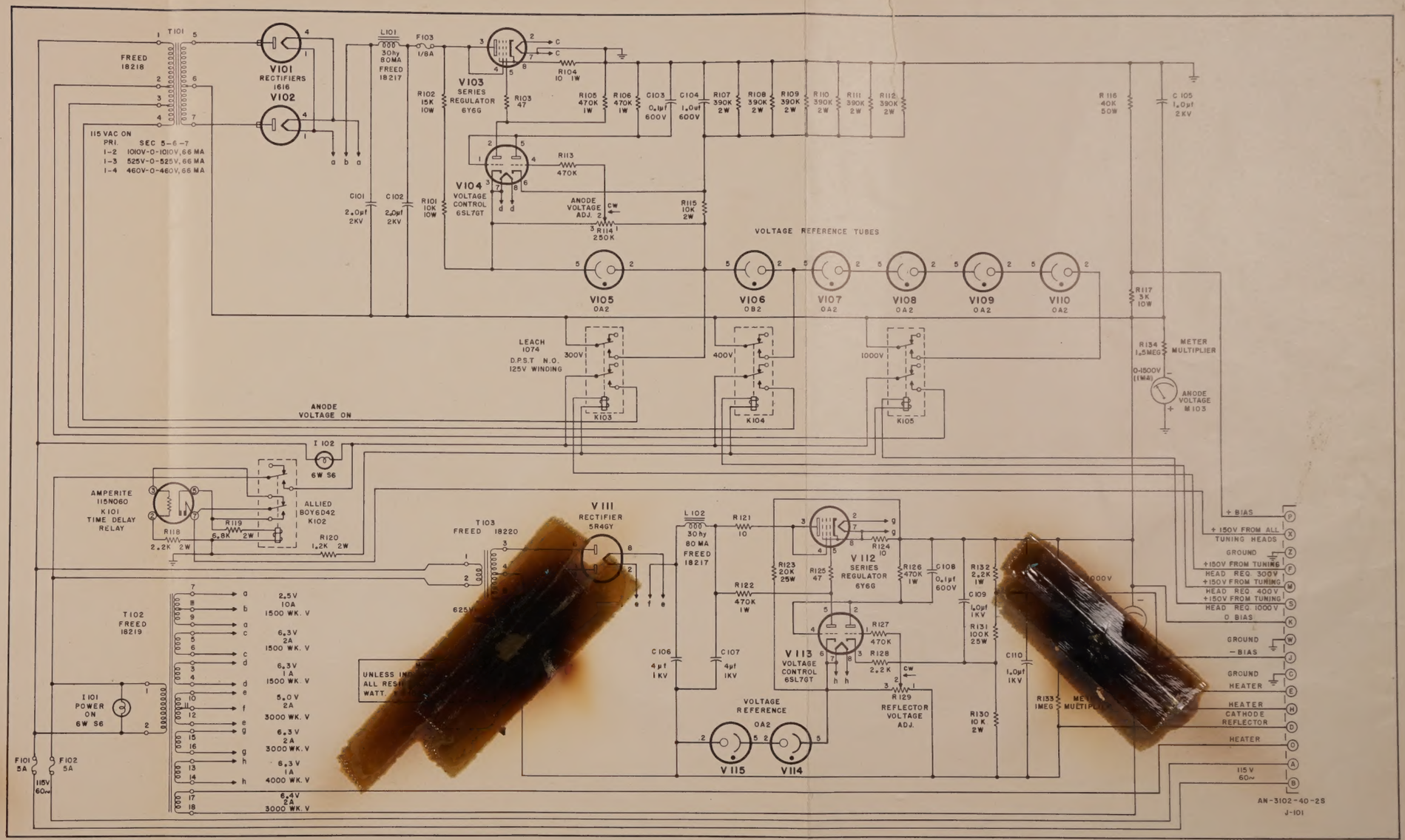


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FIGURE 10. KLYSTRON POWER UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC DIAGRAM MODEL LKU-1